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Fig. 2.

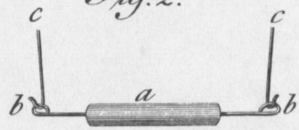
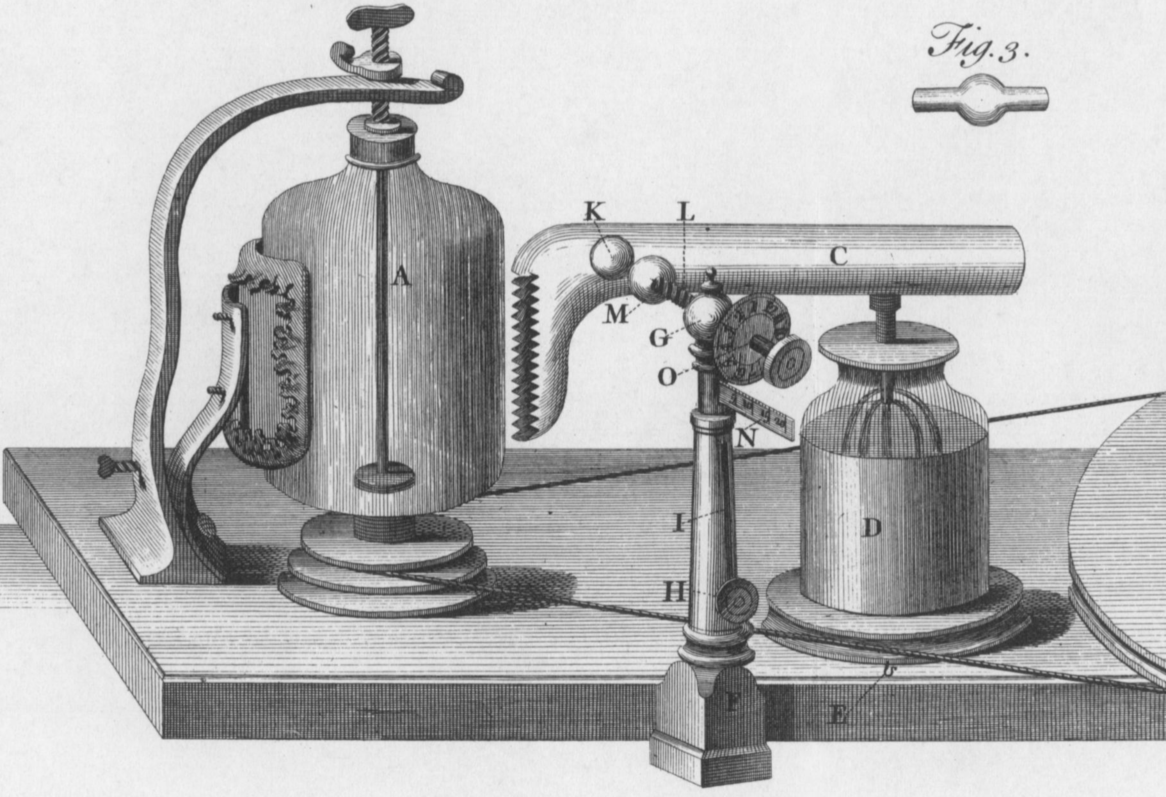
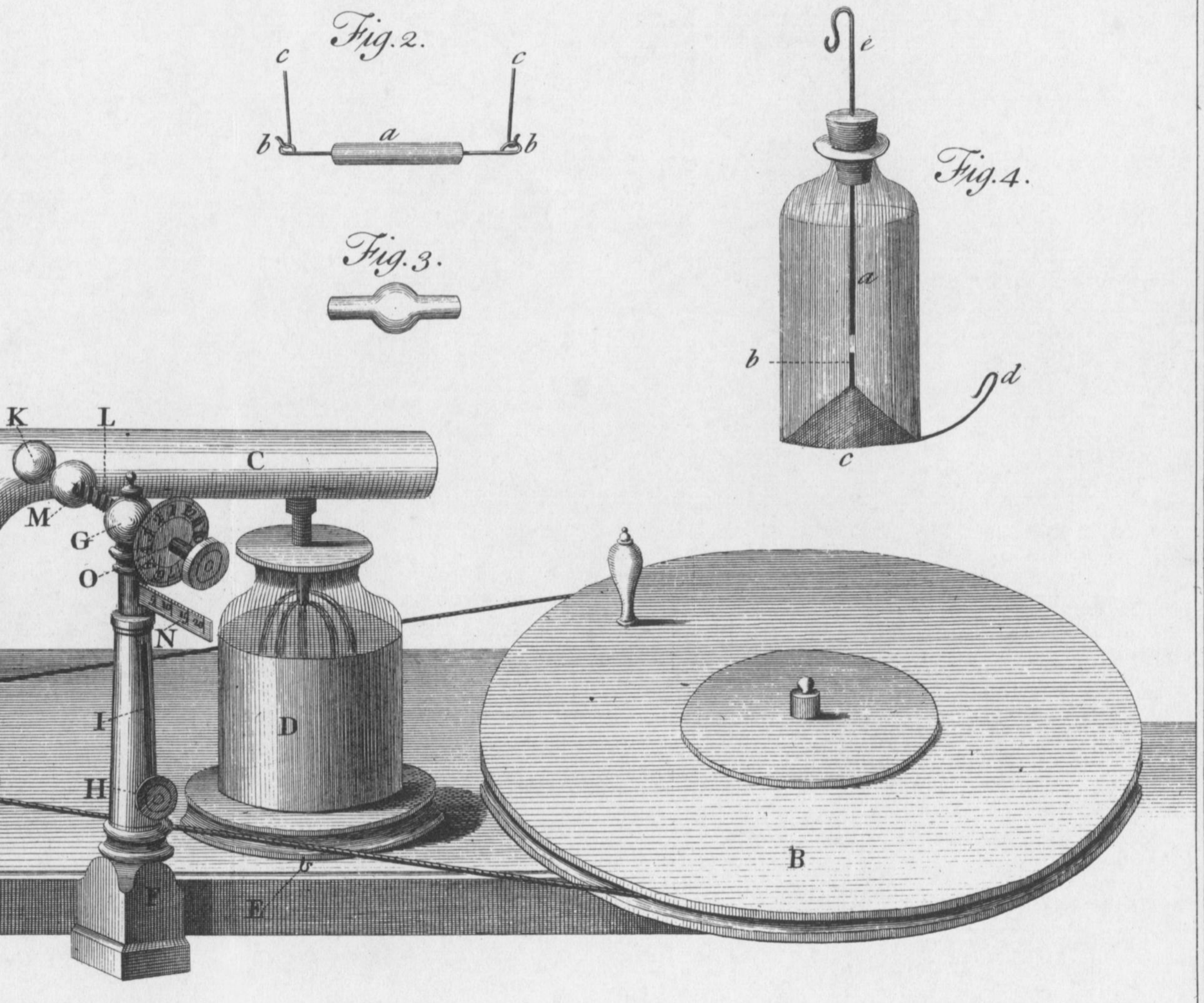


Fig. 3.

Fig. 1.





J. Mynde sculp.

Received August, 1767.

XLIV. *Description of an Electrometer invented by Mr.* Lane; *with an Account of some Experiments made by him with it: In a Letter to* Benjamin Franklin, *LL. D. F. R. S.*

Aldersgate-Street, October 15, 1766.

S I R,

Read Nov. 26, 1767. BEING employed in some electrical enquiries about the beginning of the year 1762, it occurred to me, that many experiments on this subject might be made with a much greater degree of precision, if we could determine, with any tolerable accuracy, the comparative quantity of electric fluid, with which, for any given experiment, the coated phial is impregnated.

An instrument, which I have contrived for this purpose, may not improperly be called an Electrometer. I have herewith sent you a drawing thereof [TAB. XX.] with the machine * to which I have fixed it.

* This portable machine is the contrivance of Mr. Read, mathematical instrument maker at Knightsbridge, near London.

FIGURE I.

A. The cylindrical glaſs of the machine, uſed inſtead of a globe. The cylindrical part of the glaſs is ſix inches in length, and ſixteen in circumference.

B. The wheel, at every turn of which the cylindrical glaſs revolves four times.

C. The conductor.

D. The coated phial.

E. A braſs wire loop, paſſing through the wood work to a tin plate, on which the coated phial ſtands.

F. The pillar of the Electrometer made of wood, bored cylindrically about $\frac{2}{3}$ of its length, and rendered electrical, by being long baked in an oven, and then boiled in linſeed oil, and again baked. At firſt the pillar was made of braſs, which, though it ſerved very well to determine the electric ſtroke for medical purpoſes, yet was defective in many experiments, as the table thereby became a ready conductor.

G. Braſs work, having its lower part incloſed within the bore of the pillar.

H. A ſcrew, which paſſes through the braſs work near the bottom, and fixes it in the pillar.

I. A groove for the ſcrew H to move in, when the Electrometer is moved higher or lower, as the different heights of different condenſing phials may require.

K. A well poliſhed hemiſpherical piece of braſs, fixed to the conductor.

L. A

L. A ſteel ſcrew, paſſing through the top of the braſs work, whoſe threads are diſtant nearly $\frac{1}{24}$ of an inch from each other.

M. A well poliſhed ſpherical piece of braſs, fixed to the ſcrew L, and oppoſite to K. The poliſh of K and M will often be deſtroyed by large electrical exploſions, and it ſhould again be reſtored, particularly where the experiments require accuracy.

N. A ſcale, with diviſions equal to each turn of the ſcrew.

O. A circular plate fixed to, and moving with the ſcrew, pointing at each turn to the diviſion upon the ſcale. This plate is alſo divided into twelve, to denote the parts of each turn.

The principle on which the Electrometer acts is very ſimple, being merely this; the coated phial is hereby rendered incapable of accumulating and retaining any more than a certain quantity of the electric fluid, for any intended experiment, when a metallic or non-electric communication is made from the ſcrew H to the wire loop E of the machine, and that quantity will be proportionate to the diſtance of K and M from each other, and conſequently the exploſion and ſtroke will thereby be regulated.

Thus if a perſon holds a wire faſtened to the ſcrew H in one hand, and another wire fixed to the loop E in the other, he will perceive no ſtroke, if K and M are in contact, notwithſtanding the cylindrical glaſs A acts ſtrongly. But if, by turning the ſcrew L, the ball M is diſtant from K $\frac{1}{100}$ part of

an inch, a very ſmall ſtroke will be perceived, with an exploſion from K to M; and if K and M are diſtant one inch from each other, the quantity of the electric fluid, at the time of the exploſion, will be increaſed 100 times: for example, it appears by experiment, that, if the exploſion happens after 4 turns of the wheel B, when M is diſtant from K $\frac{1}{24}$ of an inch, or 1 turn of the ſcrew; the ſame will happen at 8 turns of the wheel, when M and K are diſtant 2 turns of the ſcrew, or $\frac{1}{12}$ of an inch; and if K and M are diſtant 3 turns of the ſcrew, the turns of the wheel will be 12 at the time of the exploſion; the ſame proportion will continue ſo far as the diſtance of K and M is equal to the condenſing power of the coated phial without waſting. By waſting, I mean when the phial is ſo fully charged, that part of the electric fluid eſcapes from the mouth of the bottle, or from the conductor into the air, or to ſome adjacent non-electric. The number of turns of the wheel, when K and M are at any of the above diſtances, will be more or leſs in proportion to the ſtate of the air, the cylindrical glaſs, the cuſhion againſt which the glaſs is rubbed, or the coated phial; which laſt will not give ſo great an exploſion when the air is damp as when dry.

The fewer the number of turns of the wheel, at any given diſtance, the better the machine worketh. Thus a comparative difference between any two machines may be determined.

A wire in general is better than a chain, unleſs the chain is held very tight; particularly in very ſmall ſtrokes, the electric fluid will be loſt in paſſing from link to link of the chain.

By

By experiment it alſo appears, that the quantity of electric fluid, at every exploſion, will be proportionate to the quantity of coated glaſs, either as to the ſize of the coated phial, or to the number of phials added. For example, if the phial D has half of the coating on each ſide of the glaſs taken off, the exploſion will happen after half the number of turns of the wheel, at any of the above diſtances; and if a phial, with twice the quantity of coated glaſs, is employed inſtead of D, the number of turns of the wheel will be double; the ſame will happen if two coated phials, each equal to D, are uſed; and if three phials, the number of turns will be triple, &c.

The phial D, uſed in the following experiments, contains about 80 ſquare inches of coating on the inſide, and alſo on the outſide of the glaſs; the mouth being ſtopped with wood, prepared like the pillar, and the coating not too near the mouth of the phial, to prevent the electric fluid's waſting, and thereby the phial may be more fully charged.

As K is part of the conductor, and of M the electrometer, the diſtance between them is the diſtance of the electrometer from the conductor; whence it will be readily underſtood, when I relate the diſtance of the electrometer, in any experiments. For example, the electrometer at 20, that is, M, is 20 turns of the ſcrew diſtant from K, or $\frac{20}{24}$ of an inch.

That lightning and electricity are of very near affinity, if not the ſame, evidently appears from the many diſcoveries you have made; and as the following experiments tend to confirm the ſame, as well as

to illuſtrate the uſe of the electrometer, I hope they will not be unacceptable.

Experiment I.

A piece of moiſt tobacco-pipe clay, rolled cylindrically, *a*. fig. 2. about an inch in length, and about 2 or $\frac{3}{10}$ of an inch in diameter, having a piece of wire thruſt into each end, *b b*, diſtant about $\frac{1}{10}$ of an inch from each other, with the ſolid clay between, and the end of one of the wires, *c c*, fixed to the loop of the machine E, and the other fixed to the ſmall ſcrew of the electrometer H, will, with an exploſion at 20 of the electrometer, be inflated as in fig. 3. or if the clay is too dry, or the quantity of electricity too great, it will burſt in pieces, leaving only the clay concave near the ends of the wires; and though the experiment will in appearance differ, yet it will always leave evident ſigns of an exploſive power, or ſudden rarefaction, excepting when the wires in the clay are at too great a diſtance from each other; then the electric fluid will only run over its moiſt ſurface. If, inſtead of clay, a mucilaginous vegetable paſte is uſed, as wheat-flower and water, &c. the experiment will appear the ſame.

Experiment II.

Take a piece of common tobacco-pipe hard-baked, as uſed for ſmoaking, about an inch in length; fill the bore with clay, and put wires into each end, as in fig. 2. which applied in the ſame manner to the machine, will burſt into many pieces,

at

at 20 of the electrometer; sometimes the pieces will be driven near ten feet from the machine.

EXPERIMENT III.

A small square piece of Portland stone, with holes drilled at each end so as to admit the wires, was in like manner burst in pieces, when a second coated phial was added to increase the stroke.

The iron cramps in stone buildings are similar to the wires, and when a building is struck by lightning produces a similar effect. I observed, that when the tobacco pipe, or stone, was damp, the experiment succeeded better than when dry; and I frequently found, that either of them, after being first dipped in water, would be broken with a less explosion than before.

This observation is different from the received opinion of many, not well acquainted with electricity, that lightning is less likely to do mischief after a shower of rain than before: so far may be true, that the rain will bring down some of the lightning, and also render thatched houses, &c. less likely to take fire, but will not assist buildings that have metallic ornaments near their tops, as the weathercocks of churches, &c.

As a metallic conductor from the tops of buildings to the earth will prevent the effects of lightning on them, so will the smallest wire prevent the effects of electricity on the stone, or tobacco-pipe, when in contact with the two wires, *c c*, fig. 2.

 If

If the tobacco-pipe, inſtead of clay, is filled as above, with an electric ſubſtance, as wax, powdered glaſs, or with any non-electric ſubſtance, inferior to metals as a conductor, it will be burſt in pieces with nearly the ſame quantity of the electric fluid.

As the above experiments ſucceeded better when the ſtone or clay were previouſly dipped in water than before, I was induced to try water only.

Experiment IV.

Having made a hole, without any cracks on the ſide, through the bottom of the phial, *a*, fig. 4. which may eaſily be done if the phial is conical at the bottom, as in the figure, by holding the phial inverted in one hand, and with the other ſtriking a pointed ſteel wire againſt the apex of the cone.

Through this hole I paſſed a wire, *b*, and filled the bottom, *c*, with melted ſealing wax, leaving the other end of the wire out, at *d*; when the wax was cold, the phial was about $\frac{3}{4}$ filled with water, and ſtopped with a cork, through which a wire, *e*, was paſſed downwards, till the points of the two wires were diſtant from each other about $\frac{1}{10}$ of an inch, as near as my eye could determine a wire from the electrometer was fixed to *e*, and another from the loop of the machine was fixed at *d*; by an exploſion, at 20 of the electrometer, the phial burſt in

in pieces, the top falling from the bottom near the point of the lower wire. Another phial was fitted in the ſame manner, and the cork cut longitudinally, that the air might freely paſs at the time of the exploſion, but this made no ſenſible difference: often times the phial is ſo cracked as to reſemble radii from a center.

If oil is uſed inſtead of water, the event will be the ſame.

The quantity of electricity neceſſary to burſt the phial, appears to vary more in proportion to its thickneſs than its ſize; many phials of various ſizes may be broken at 10 of the electrometer, while others, nearly of the ſame ſize, remain ſound, with a ſtroke at 30, or even more.

I generally found green glaſs more difficult to break than white.

When the phial is not broken by the electric ſtroke, the agitation of the water may be ſenſibly obſerved at the inſtant of the exploſion, and the electric ſpark evidently ſeen to paſs through the water, from the point of one wire to the other.

This remarkable appearance of the electric fluid's paſſing through water may be obſerved, when the electrometer is at a ſmaller diſtance from the conductor, if the wires are nearer to each other.

I have broken many phials by the electric ſtrokes as above-mentioned, when the wires have been at the various diſtances, of above 1 inch to $\frac{1}{20}$ of an inch from each other, as near as my eye could determine; but the diſtance of about $\frac{1}{10}$ of an inch I uſually prefer.

The

The above experiments I have often repeated, and may therefore be relied on: want of leiſure has prevented me from purſuing them more minutely. But I hope they will ſerve as hints to others of more abilities and leiſure, than

Your reſpectful

humble ſervant,

T. Lane.

Received